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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/780,863	02/19/2004	Soon Hyung Hong	2236.0010000/JUK/SMW	1952

26111 7590 02/21/2008
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EXAMINER

LAZORCIK, JASON L

ART UNIT	PAPER NUMBER
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1791

MAIL DATE	DELIVERY MODE
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02/21/2008

PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 10/780,863	Applicant(s) HONG ET AL.	
	Examiner JASON L. LAZORCIK	Art Unit 1791	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 16 November 2007.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-9 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-9 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION**Miscellaneous Matters**

Applicant notes that the Office Action of August 16, 2007 incorrectly indicated that Applicants reply filed June 4, 2007 as a CPA and that said communication should have reflected the applications status as a request for continued examination (RCE) under 37 C.F.R. §1.114. The Examiner acknowledges this inadvertent error and is in agreement with Applicants position.

In summary, a request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed by Applicant on June 4, 2007 in this application after final rejection. Since this application was eligible for continued examination under 37 CFR 1.114 on the filing date of June 4, 2007, and the fee set forth in 37 CFR 1.17(e) were timely paid, the finality of the Office action dated January 3, 2007 was effectively withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on June 4, 2007 has been entered and was treated as a RCE pursuant to 37 C.F.R. §1.114. The Examiners prior indication of the application status as a CPA on August 16, 2007 was inadvertent and erroneous.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been

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obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 1-7 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hwang et al. (J. Mater. Chem., 2001, 11, 1722-1725) in view of Smalley et. al. (J. Nanosci. Nanotech, 2003, V3 (1), 81-86).

Briefly, Hwang teaches a process of forming a carbon nanotube reinforced ceramic nanocomposite. As indicated by Applicant in the reply to Office Action dated November 2, 2006, the Hwang reference teaches sonication of the CNT solution for 10 minutes but it fails to explicitly provide for an extended sonication period of between 2 and 10 hours. However, Hwang clearly indicates that a stable and homogeneous suspension is critical to the quality of the product derived from the disclosed process, and that said suspension is achieved through the sonication step.

Smalley et. al. (J. Nanosci. Nanotech, 2003, V3 (1), 81-86) teaches the relationship between sonication time and CNT dispersion in aqueous solution for time periods up to approximately 5 hours. With specific attention to the instant reference Figure 2, Smalley tracks the intensity of a spectral feature indicative of

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dispersion quality as a function of time under continual sonication. The reference teaches that dispersion quality increases at least through the first four hours of sonication. It is the Examiners position that optimization of the sonication time was a recognized result effective variable of the dispersion quality at the time of the invention and that said time period would have been optimized through routine experimentation by one of ordinary skill in the art.

More specifically, it would have been obvious to one of ordinary skill in the art at the time of the invention to sonicate the CNT dispersion for a time period up to at least 5 hours in an effort to provide a high quality dispersion of CNTs. A high quality dispersion would have been a routine goal for one of ordinary skill seeking to optimize the uniformity of the resultant ceramic composite, and a sonication period between 2 to 10 hours is a minor and obvious extension over the prior art.

Therefore as presented in the prior Office Action regarding Claim 1, the instant reference teaches:

1. Adding carbon nanotubes (CNTs) to an aqueous solution of cetyltrimethylammonium bromide which is read as dispersing carbon nanotubes in a dispersion medium (Pg. 1722, Column 1, Lines 38-40)
2. Sonicating the solution or "dispersion" from (1) above (Pg. 1722, Column 1, Lines 40)

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3. Adding sodium silicate and sodium aluminate to the sonicated solution from (2) above which is understood as dispersing a water-soluble salt in the sonicated dispersion. (Pg. 1722, Column 1, Lines 42-44)
4. Sonicating the solution or “dispersion” from (3) above (Pg. 1722, Column 1, Lines 44)
5. Placing the solution into an autoclave and heating at $\sim 110^{\circ}\text{C}$ to form a yellowish silicate powder followed by calcinations in air at 400°C to oxidatively remove surfactant molecules (Pg. 1722, Column 2, Lines 2-3). This disclosure is read in the immediate claim as drying and calcinating the sonicated dispersion of (4) where the water soluble salt or sodium silicate forms a ceramic matrix of SiO_2 post-calcination. Steps 1-5 yields a ceramic nanocomposite powder referred to by the authors as SiO_2 -CNT rods wherein the CNTs are homogeneously encapsulated by or “dispersed in” a SiO_2 ceramic matrix (Pg. 1724, Column 1, Lines 11-12).
6. The SiO_2 -CNT rods from (5) are mixed with SiO_2 powder and pressed into a disc followed by calcination or “further drying” in air at 400°C and calcination in an N_2 atmosphere at 1050°C to form a final composite disc.

Finally, Hwang provides concluding observations regarding the calcined salt-CNT materials and the composite ceramic material produced by mixing and

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hot pressing a blend of the SiO₂-CNT material with SiO₂ powder. Specifically, Hwang discloses that "it can be deduced that the mechanical strength of the SiO₂-CNT glass rods is stronger than the interactions between the glass rods and the matrix" (pg 1725, col.1, lines 13-28). It follows from this disclosure that The CNTs in fact do form a "chemical bond" or a chemical interaction with the ceramic matrix material as presently claimed in Applicants amended claim 1.

Claim 2 is obvious in the rejection of Claim 1 above wherein it was set forth that the CNT dispersion is an aqueous solution.

Claim 3 is obvious in light of the rejection of Claim 1 wherein sodium silicate and sodium aluminate are understood to be metal-based salts of the metals Silicon and Aluminum, respectively, and at least the sodium silicate is capable of being formed into a SiO₂ ceramic matrix prior to calcination.

Claim 4 is obvious in light of the rejection of Claim 1 wherein a ceramic matrix of SiO₂ is from the group including silicon oxides.

Claim 5 is obvious in light of the rejection of Claim 3 and the rejection of Claim 1 wherein a ceramic matrix of SiO₂ is from the group including silicon oxides.

Claim 6 is obvious in light of the rejection of Claim 1 above wherein the claimed drying temperature range of 80 to 100°C is understood to be encompassed by ~110°C or "approximately" 110°C.

Alternately if it is deemed that "approximately" 110°C fails to read upon the disclosed temperature range, it would be obvious to one of ordinary skill in the

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art, seeking to dry a dispersion, to perform said drying step within a temperature range suitable for evaporating the dispersion medium. In the immediate case wherein said dispersant is water with a normal boiling point of 100°C, drying said dispersant at approximately 110°C would obviously encompass drying the dispersant in the temperature range of 80°C to 100°C since the latter range would yield materially equivalent drying effect.

Regarding Claim 7, Hwang indicates that “the silicate powder” described in the rejection of Claim 1 above is calcined in air at 400°C to oxidatively remove surfactant molecules. Although the instant reference does not explicitly teach the calcinations in the temperature range of 300 to 350°C as claimed, it is the examiners position that one of ordinary skill in the art at the time of the invention would be fully capable of determining the appropriate calcination temperature for a given ceramic matrix material.

While the Examiner acknowledges that the prior art range does not explicitly overlap the claimed range, the prior art calcining temperature of 400°C would be recognized by one of ordinary skill as so near the prior art temperature range as to be patentably indistinct therefrom. More specifically, one of ordinary skill in the art would have found ample motivation to explore lower calcining temperatures in an effort to reduce processing costs associated with manufacturing the ceramic composite material. Therefore absent any compelling and unexpected results showing to the contrary, claimed calcining temperature range of 300-350°C is held as a merely obvious extension over the prior art teachings.

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With respect to Claim 9, the claim requires a calcinations temperature of 400oC or lower. Hwang indicates that “the silicate powder” described in the rejection of Claim 1 above is calcined in air at 400°C to oxidatively remove surfactant molecules. As such the Hwang process reads on the broad limitation of the claim which requires a calcination temperature of 400°C or lower. Further, where no distinction is drawn between the process of drying and the process of calcination, it is understood that the act of heating the silicate powder to the calcination temperature inherently requires traversing the claimed temperature range of 300 to 350oC. Since the primary solvent utilized by Hwang is water as indicated above, with a normal boiling point of 100oC, the act of heating the silicate powder through the temperature range of 300 to 350oC is understood to “further dry” said ceramic matrix.

Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hwang (J. Mater. Chem., 2001, 11, 1722-1725) as applied to Claim 1 above and in further view of Chang (6,420,293).

Hwang teaches that the SiO₂-CNT powder is to be calcinated in an N₂ atmosphere at 1050°C which falls within the claimed temperature range of 400-1700°C. Hwang fails to explicitly set forth that the calcination of the ceramic matrix, requiring a calcination temperature of 400°C or higher as indicated above, should be performed under a high vacuum as claimed. Chang teaches that “heating of carbon nanotube materials at elevated temperatures in an oxidizing environment typically results in chemical changes in the surface of the particles

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(Column 3, Lines 51-54) and specifically that "heating in air at 640°C results in the formation of carboxyl and carbonyl groups at the particle surface" (Column 3, Lines 57-59). Both the N₂ atmosphere and a high vacuum environment are commonly utilized and well appreciated in the art as non-oxidizing environments. Processing under a high vacuum would be an obvious alternative for the nitrogen atmosphere since the Hwang process utilizes calcination temperatures of 1050°C and damage to the CNTs occurs at temperatures in excess of 640°C under oxidative environments as indicated by Chang. Therefore it would be obvious to one of ordinary skill in the art seeking to minimize said oxidative damage to substitute a high vacuum environment for the nitrogen atmosphere in the Hwang process since both nitrogen and high vacuum provide the requisite non-oxidative environments.

Response to Arguments

Rejection of Claims 1-7 and 9 under 35 U.S.C §103(a)

Applicant argues that that in accordance with the recent court decision in KSR International vs. Teleflex, Inc., the Court held that it was "important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the [prior art] elements" in the manner claimed.

Applicant continues citing case law stating that in order to determine whether

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there was an apparent reason to combine the known elements in the claimed fashion, an "analysis should be made explicit (and) ... there must be some articulated reasoning with some rational underpinning to support a legal conclusion of obviousness".

Argument #1)

Applicant alleges that Hwang does not teach or suggest the formation of chemical bonds between the carbon nanotubes and the matrix. In support of this position Applicants allege that the presence of surfactants used in the preparation of a CNT solution would necessarily preclude the formation of a chemical bond with the ceramic matrix.

In support of this position, Applicant cites a passage from Hwang (pg 1722, col3, 3rd ¶) which states that "in order to avoid formation of aggregates, CNTs were mixed with C16TMAB surfactant in aqueous solution." Referring to Hwang's note that in the absence of these surfactants the CNT's tend to "eventually" precipitate from solution, Applicant concludes that the Hwang process can not form chemical bonds between the matrix and the CNTs.

On this matter, the Examiner disagrees.

After careful review of the Hwang disclosure, the Examiner can find substantially no evidence to support Applicants allegation that chemical bonding of any form between the matrix and the CNTs is precluded under the Hwang

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process. Rather, the cited passage in Hwang relates to the formation of a homogeneous dispersion of CNTs prior to addition of the water soluble salt. The formation of a stable aqueous suspension of CNTs by addition of surfactant molecules as described in the instant passage neither implicitly nor explicitly precludes the ultimate formation of "chemical bonds" between the CNTs and the subsequently added soluble salt.

Further, Hwang teaches that the surfactant molecules are "oxidatively removed" in a calcination step. Since the surfactants are ultimately removed via oxidative pyrolysis, Applicant can hardly assert that said surfactant inhibits the formation of "chemical bonds" in the product ceramic.

Finally, as stated in the rejection of claims above, Hwang provides a few concluding observations regarding the calcined salt-CNT materials and the composite ceramic material produced by mixing and hot pressing a blend of the SiO₂-CNT material with SiO₂ powder. Specifically, Hwang discloses that "it can be deduced that the mechanical strength of the SiO₂-CNT glass rods is stronger than the interactions between the glass rods and the matrix". It follows from this disclosure that The CNTs in fact do form a "chemical bond" with the ceramic matrix material as presently claimed in Applicants amended claim 1.

It should appear evident from the foregoing, in the absence of any evidence to the contrary, that Applicants argument that the Hwang process can and/or does not result in formation of chemical bonds between the CNTs and the ceramic matrix are represent unsubstantiated Attorney argument. Specifically,

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Applicant has provided no conclusive evidence in support of this assertion and it therefore follows that these arguments are held to be mere conjecture and attorney argument. The Official policy regarding Attorney argument is clearly outlined in MPEP §2145 [R-3];

“Attorney argument is not evidence unless it is an admission, in which case, an examiner may use the admission in making a rejection. See MPEP § 2129 and § 2144.03 for a discussion of admissions as prior art. The arguments of counsel cannot take the place of evidence in the record. In re Schulze, 346 F.2d 600, 602, 145 USPQ 716, 718 (CCPA 1965); In re Geisler, 116 F.3d 1465, 43 USPQ2d 1362 (Fed. Cir. 1997) (“An assertion of what seems to follow from common experience is just attorney argument and not the kind of factual evidence that is required to rebut a prima facie case of obviousness.”). See MPEP § 716.01(c) for examples of attorney statements which are not evidence and which must be supported by an appropriate affidavit or declaration.

Argument #2)

Applicant argues that Hwang and Smalley do not teach or suggest that the CNTs are homogeneously dispersed in the ceramic matrix.

Applicant argues that Claim 1 requires the carbon nanotubes to be homogeneously dispersed in the ceramic matrix and that Hwang does not teach such a homogeneous dispersion in the disclosed composite. The key to Applicants argument lies in the definition and construction of the terms “homogeneous” and “dispersion” and specifically whether the prior art structure is properly interpreted as a homogeneous dispersion.

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Applicant points to various common definitions for the term dispersed stating that one of ordinary skill would recognize the term disperse to variously encompass definitions including “to break apart and go different ways”; “to send or drive into different parts”; “to scatter”. From this general definition, Applicant asserts that the CNT-SiO₂ materials produced by the Hwang process which are at various times described as “aligned”, “roughly parallel” and “packed” can not be construed under any circumstances as being “homogeneously dispersed” as claimed.

In response, Applicant is initially advised that the specification as originally filed presents neither an unambiguous nor an explicit definition for the contested terminology, namely the definition of “homogeneous” or “dispersed”. Although Applicant is entitled to function as his own lexicographer, in the absence of an explicit definition of the contested terms, the claims are construed in a manner which is consistent with the broadest reasonable interpretation.

To this end, Applicant was advised in the prior Office Action that the term “homogeneous” may be appropriately construed as referring to a material which is “Uniform in structure or composition throughout” (*Dictionary.com Unabridged (v 1.1)* and *The American Heritage® Dictionary of the English Language, Fourth Edition*. Both references Retrieved August 15, 2007, from Dictionary.com website: <http://dictionary.reference.com/browse/homogeneous>). Similarly, the term “disperse” may appropriately construed as an action which “causes (particles) to separate uniformly throughout a solid, liquid, or gas” (disperse.

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(n.d.). *Dictionary.com Unabridged (v 1.1)*. Retrieved February 11, 2008, from Dictionary.com website: <http://dictionary.reference.com/browse/disperse>) or “To distribute (particles) evenly throughout a medium” (disperse. (n.d.). *The American Heritage® Dictionary of the English Language, Fourth Edition*. Retrieved February 11, 2008, from Dictionary.com website: <http://dictionary.reference.com/browse/disperse>). It follows that a homogeneously dispersed material may in the broadest reasonable interpretation construed to mean a material having a separated particle structure which possesses a roughly even or uniform structure or composition.

As noted previously, the Hwang disclosed tendency for the nanotubes to “roughly” align on the sub-micrometer or nanometer scale as indicated in the Hwang reference does not imply that said nanotubes are not uniformly distributed through the matrix. Further, Applicant has provided no evidence to suggest that the assembly of nanotubes and matrix material into macro-scale rod structures resulting from the Hwang process would be inconsistent with the broadest reasonable interpretation of the contested term as a uniformly dispersed or separated material. Restated, a tendency of the CNT's to “roughly” align into self-assembled, hierarchical structures does not imply that the carbon nanotubes are not uniformly separated through the entirety of the matrix or even within a single microrod.

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In response to applicant's argument that the references fail to show certain features of applicant's invention, it is noted that the features upon which applicant relies (i.e., "the aligned carbon nanotubes are not "scattered" or "sent off in different directions" within the microrods") are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

In summary, Applicant has provided no explicitly limited definition of the term "homogeneously dispersed". Further no convincing evidence has been provided to show how the materials resulting from the Hwang process materially differ from that of the claimed invention or how said materials are in any manner inconsistent with the broadest reasonable interpretation of the claim language. Specifically, Applicant has provided no evidence to suggest that the microrods of the prior art lack "a uniform or even structure or composition".

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As a final matter, Applicant is advised that the Hwang process provides for a two stage process. The first stage of the process comprises forming a CNT-SiO₂ microrod structure wherein the CNT materials are uniformly dispersed within a silica matrix. The second stage comprises mixing the CNT-SiO₂ microrod structures with a powdered SiO₂ material and hot pressing to form a consolidated ceramic matrix. Therefore, the distribution of CNTs in the ceramic material (SiO₂) may be viewed upon either the scale of an individual microrod or alternately upon the scale of macroscale CNT-SiO₂ microrod / SiO₂ composite scale.

With respect to this issue, Applicants arguments appear to be exclusively directed to the distribution of CNTs within a single microrod structure. Should Applicant continue to allege that the CNTs lack a structure which is consistent with the broadest reasonable interpretation of a homogeneous dispersion upon the microrod scale, it is then Examiners position that said CNTs are at least homogeneously dispersed at the macroscale level.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is

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filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JASON L. LAZORCIK whose telephone number is (571)272-2217. The examiner can normally be reached on Monday through Friday 8:30 am to 5:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Steven Griffin can be reached on (571) 272-1189. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Steven P. Griffin/
Supervisory Patent Examiner, Art
Unit 1791

JLL